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ABSTRACT

An interview investigation was undertaken in which a group of nurses and a group of technicians reasoned about evidence for the existence of a causal relation in a medical and in a technical case. A statement about the existence of the relation was presented and the subjects were then asked as to what evidence there might and should be behind such a statement. In an unstructured in-depth interview, they outlined their conceptions of the problem of evidence in each example by suggesting the kinds of investigations that would be relevant. The nurses and technicians relied on their different knowledge of the specific subject-matter and they placed the evidence problem in different contexts giving different meanings to the problem. (Author)

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The role of experience in adult thinking about evidence for causal interpretations

Lennart Svensson

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ABSTRACT

An interview investigation was undertaken in which a group of nurses and a group of technicians reasoned about evidence for the existence of a causal relation in a medical and in a technical case. A statement about the existence of the relation was presented and the subjects were then asked as to what evidence there might and should be behind such a statement. In an unstructured in-depth interview, they outlined their conceptions of the problem of evidence in each example by suggesting the kinds of investigations that would be relevant. The nurses and technicians relied on their different knowledge of the specific subject-matter and they placed the evidence problem in different contexts giving different meanings to the problem.

INTRODUCTION

Experience and thinking are two concepts that have been delimited and related in several different ways. The main difference in this respect has been between two general schools of thought; rationalism and empiricism. In the rationalistic school, thought is considered the independent basis for true knowledge, in contrast to experience which reflects conventions developed in a haphazard way through practice and is transmitted through tradition. To the empiricists, on the other hand, experience in the form of distinct sensory impressions is the all-important basis for human activity and knowledge. Both philosophy and empirical research into human activity today seem to have overcome an extreme emphasis on one or other of these positions. The concern has become one with a more integrated and holistic view of thinking and experience.

At the same time, an inclusive and relational meaning was given to experience by Husserl in his phenomenology and by Dewey in his more instrumentally and pragmatically oriented philosphy. Husserl (1948) deals with the nature of experience in terms of the character of the relation between the subject or ego and the world and the relation between simple sensory awareness and logical thinking and the idealization of scientific thinking. In Husserl's phenomenology, there is an emphasis on the world in the subjective sense of a life-world and on the totality of this world as a basis for specific sensations, cognition and logic.

Dewey (1938) also gives experience the meaning of a totality, but deals with the instrumental function of experience rather than its psychological-epistemological nature. He also focuses on the developmental character of

experience and emphasizes that experience has continuity which means ´that every experience both takes up something from those which have gone before and modifies in some way the quality of those which came after´ (p. 35). He states further: ´There is some kind of continuity in every case. It is when we note the different forms in which continuity of experience operates that we get the basis of discriminating among experiences´ (p 35). The quality of experience and the progressive organization of experience are main concerns of Dewey.

Both Husserl and Dewey emphasize a holistic meaning of continuity of experience, the role of the totality of previous, present and future experience. Within a general framework of a holistic relational view of experience, one main question for empirical research concerns the more specific nature of the continuity of experience. In the ways of dealing with this question prevalent in empirical research, we find a difference similar to that between rationalism and empiricism. The difference is one between emphasizing structures and emphasizing specific contents as basic to the continuity of experience. The approach taken here in relation to the theme ´the role of experience in adult thinking´ is to give a holistic meaning to experience in line with Husserl´s and Dewey´s use of the word. This means that structures and specific contents are considered parts of totalities of experiences. The empirical question raised then is how thinking may be found to be related to previous experience in this broad sense.

Alongside this interpretation of the meaning of experience is an emphasis on the active nature of thinking as a part of experience. The individual is seen as creating or constructing specific experiences within the totality of his experience. The question raised here concerns the nature and conditions for such constructions of qualitatively different excperiences. This has been

investigated in early empirical research into thinking and remembering (cf Bartlett, 1932, 1958; Duncker, 1945; Wertheimer, 1945). The constructive nature of experience has also been further described in recent research into qualitative differences in thinking (cf Marton, Dahlgren, Svensson and Säljö, 1977; Neisser, 1976; Raaheim, 1978). The qualitative differences described represent differences in reasoning or conception where structural and contextual aspects or parts are described as integrated parts of the whole of an experience.

The question addressed here concerns the relation to the total previous experience of the whole of a reasoning. For some time, empiricistic, associanistic and behaviouristic descriptions were dominant, representing a reaction against earlier rationalistic traditions. However, more rationalistic and structuralistic answers are now commonly given to this kind of question. The general meaning of the answers is that the reasoning has the character of a generalization and application of a form, structure or rule and its modification to the specifics of the situation. However, recently there has been some discussion within the field concerning the generality of forms of thinking versus the importance of contextual factors.

Piaget (1950) emphasized the generality of forms of thought or structures. According to his theory, one would also expect adults like our subjects to be formal reasoners (Inhelder and Piaget, 1958). Piaget (1972) has modified his assumption about the generality of forms of thinking and states that adults may be expected to be formal reasoners within their field of expertise but not necessarily within other fields. Still, the focus on forms and structures as the main aspect of thinking is preserved as is the emphasis on their generality, although within certain limits. The concern with forms and

structures of thinking is associated with descriptions of thinking in terms of strategies. The conception of the relation between strategies and external demands, primarily task characteristics, is totally in line with the assumption about the general importance of the formal aspects of thinking.

There may be a conflict between task characteristics and available strategies which Piaget calls resistance. Piaget (1971) says, 'Some resistances of objects are unpredictable. When one encounters them one can explain them, but always after the event. It is not possible to have a general theory of thes resistances' (p. 11). Thus, according to this view, generalizability and the theory are linked to the formal aspects of thinking. At the same time, Piaget (1977) aknowledges that resistances or content factors are important in the development of strategies because they are a force in the equilibration process '...the difficulties the subject has to surmount are shown in the form of nonbalances caused by obstacles or resistance of new contents to the forms until now found to be sufficient. The victory over these obstacles open new possibilities. This is what we try to show in detail from our observations' (p. 197).

Piaget's theory has been challenged on various grounds. Riegel (1973) emphasized the dialectic nature of the relation between strategies and content-context. Johnson-Laird & Wason (1977) demonstrate a great variation in the form of selection of evidence depending upon a variation in content when the form of the task is the same. Most of the criticism of the Piagetian theory has been based on descriptions of variations in forms (strategies) across different contents and contexts. Hundeide (1977) and Linn (1980) present overviews of this empirical work. The present work represents a similar emphasis on content and context rather than on forms and strategies.

The general position argued for here is that the totalities of the integrated structure and content of separate experiences, have to be considered the basis for relations between previous and subsequent experiences. What is suggested is that the growth of experience and the development of knowledge represent the appropriate conceptual framework for understanding human activity, rather than the development of intelligence or logical thinking, which has been the commonly favoured framework.

In empirical research on thinking and learning, and especially in research in educational contexts, the importance of experience or previous knowledge is commonly acknowledged. The importance of previous experience to the phenomena studied creates many problems. We do not want to enter into a methodological discussion here but we can note that different attempts to deal with previous experience in the form of external controls have been less than successful. Nor have attempts to describe previous experience been very successful. In research relying on the definition of variables, tasks and measurements in advance, it is very difficult to deal with the question of previous experience. Dealing with previous experience in terms of predefined variables entails taking decisions as to what previous experiences and what consequences of these it is relevant to consider. This is mainly done in two ways, by considering the background of the subjects in certain respects and/or by preobserving the subjects´ knowledge, skills and interests. The main problem is the need to restrict the observations. This requires knowledge about what the relevant aspects of the previous experience are, a knowledge that is usually a part of the problem to be answered in the research. There is an apparent risk of missing important aspects and previous experience is not ready available for external control.

To clarify the relation between previous (and total) experience and a later (and specific) experience, it seems more fruitful to start from the later experience. This is also done in research relying on predefined variables in the sense that the researcher tries to decide what the relevant previous experience is on the basis of knowledge of the nature of the later activity focused on. What is suggested here is that instead of trying to guess what the relevant variables are with the additional problem of finding out the appropriateness of the guesses made, one could rely still more on the later activity. However, this takes a somewhat different view of the problem of investigating the relation between previous experience and later activity. The traditional approach includes the definition and observation of independent and dependent variables and the relating of the observations to find out to what extent there is a relation. The approach suggested here is to focus on the later activity in order to explore what the relation to previous experience is on the basis of the characteristics of the activity; in other words, to find out in what sense previous experience is present in the activity.

In the empirical study to be presented, the aim has been to describe variation both in form, content and context of thinking in an interdependent way. From such a starting-point it becomes important not to restrict the content and context of thinking any more than the form of thinking. This is contrary to the approach in most studies on reasoning. The usual approach is to present all the necessary information and to try to control the context of thinking by giving an instruction aiming at establishing a frame common to all the subjects. As we know, this does not prevent subjects from conceptualising the content differently and placing it in different contexts. Raaheim (1978) actually describes this as the main basis for differences in problem-solving.

In the present study, the restrictions introduced by the investigation are no more extensive as regards content and context of thinking than they are for forms of thinking.

In the investigation, we have adressed the question of how the subjects' previous experience is represented in their reasoning about the suggested causal relations. To a considerable extent, their reasonings actually tell us what previous experiences they make use of. These are the most important parts of previous experience when it comes to understanding the relation between the later reasoning and the previous experience. When the subjects make use of something that is not given in the situation, they must have access to this something through their previous experience.

DESIGN

A group of fourteen nurses and a group of fourteen technicians were interviewed. The interviews centered on what kind of evidence the interviewees brought up in substantiating a relation between two factors in a medical and in a technical case. The reasoning about each case followed a short piece of information presented by the interviewer. First, one case was treated and then the other. Half of each group treated the medical case first and the other half the technical one first. (Due to a mistake, the distribution was eight to six among the nurses.) The subjects were randomly assigned to the different seqeunces.

In both groups there was great variation in age and number of years in professional work. All the subjects had been working in their profession for a minimum of two years. The subjects had just started a course of study to

become teachers within their fields. Each group of subjects was selected from among students taking the same teacher-training course at the University of Göteborg. They were selected so as to obtain as heterogeneous a group as possible with respect to age and professional career. However, among the technicians, who constituted a very heterogeneous group, those selected were in jobs which were seen to require more technical skills. They were car mechanics, workshop mechanics, electricians, telephone engineers and welders.

All interviewees were presented with the same two very brief pieces of information. These presented the medical and the technical cases and gave the starting-points for reasoning about each case. No further information was given about the investigations referred to in the information. After having received the information, the subjects were asked what they thought was meant by the assertion that there existed a relation. The rest of the reasoning about the cases concerned how the subjects believed that the investigations had been carried out and how they thought that one could investigate the relations. The interview was more or less a session in which the subjects outlined the ways of investigating the relations that they could think of and could find probable. The initial pieces of information presented were the following:

Medical case

In recent years, there has been a growing concern with work-related medical problems. A short time ago there was a report about an investigation of employees at a chemical-engineering factory which uses chrome in its manufacturing processes. The investigation showed that there was a relation between the presence of chrome in the air and cancer in the lungs.

Technical case

In recent years, the surface of streets and roads has been changed. There has been a change from surfaces of asphalt, which includes small stones, to surfaces where the stones are somewhat larger. This change has taken place mainly for reason of safety, to avoid slippery roads. At the same time noise is an environmental problem, particularly in relation to traffic. The National Road and Traffic Institute has carried out investigations of noise from the friction of car tyres against road surfaces. A relation has been found between the size of the stones in the surface and noise from the friction of the tyres against the road.

The issues focussed on in the interviews and the questions put to the interviewees are very difficult to deal with. Since the subjects had had no scientific training they could not be expected to have thought about these matters before, at least not to have thought about them in the careful way required of them in this interview situation. This was made clear to the subjects prior to raising the issues. They also agreed to approach the situation as one where they would not be expected to have any ready-made answers; rather, it would be one where during the interview they would try to find out what could be the case in the different issues raised. It was emphasized that the interviewer was not interested in whether the answers were right or wrong but in the subjects´ way of thinking about the issues.

The main guiding and structuring factor in the interviews was the interviewer´s focus upon the investigation of relations. This was combined with the intention of giving the interviewers an opportunity to express a distinction between statistical and causal relations in any way they would prefer and were able to do. Thus the interviews were rather unstructured in

the sense that the questions were not standardized, but at the same time they were very much focussed on the topic set. The aim was to pose questions in relation to the interviewees' line of reasoning. The interviews were taped, transcribed and analysed.

ANALYSIS

The parts of the transcribed interviews that concerned the medical and the technical case were analysed separately. Two different kinds of analysis representing two different perspectives and aims, were carried out. The aim of the first analysis was to describe the participants' conceptions of the problem of finding evidence for the causal interpretation of the relation in each case. The perspective was that of finding the models of investigating and arguing about the relations expressed by the interviewees. The aim of the second analysis was to describe what the interviewees were talking about when talking about the evidence for the relation. The perspective was that of finding what the phenomena or parts of reality they were referring to. The first analysis was carried out first and both analyses concerned the whole of the interviews but were interpreted from the two different perspectives.

In the first analysis, the most significant parts of the interviews, within the aim and perspective considered, were identified and preliminary descriptions of the conceptions expressed were developed for each interview. The final description was based on comparisons between the interviews and represents a set of categories which describes the main and fundamental similarities and differences between the conceptions expressed. Also, the aim of finding differences between the nurses and technicians was a part of the comparison and grouping of the conceptions. Thus, the analysis should answer

both the question of what were the most fundamental differences in conception of the evidence problem and whether there were fundamental differences between the nurses and the technicians. The analysis and the categories developed have been more extensively presented in Svensson (1980), where the variation within categories is described and in particular the borderline cases between categories.

The design of the investigation, i.e. the combination of the two groups and the two relations to be reasoned about, aimed at illuminating the rule of previous experience for the ways of reasoning. The differences in reasoning could be related to the general difference in background of the two groups. On a certain level, this gives an understanding of the dependence of the reasoning upon previous experience. The aim of the second analysis has been to further clarify the nature of this dependence by attending to the specific content of the subjects' reasoning about each case. In the second analysis, the focus was on what the interviewees were talking about. There was also an interest in what they were referring to in the sense of what experiences or knowledge they were referring to and in whether there were any clear differences between the nurses and the technicians in these respects. Differences that seem to be both fundamental in relation to the conceptions of the relations and clear differences between the groups were found. The similarities and differences were summarized in the form of a number of main categories. As in the first analysis, these categories are based both on summarizing each interview and comparing and grouping the interviews.

In the third part of the total analysis, the results from the two analyses described were related. Additional observations concerning the order of the different expressions referred to and the familiarity with the themes talked

about were also used in the interpretation of the relation. The totality of the result was interpreted from the perspective of the role of past experience in the reasoning about the evidence for the causal interpretations.

Thus, the results concern the participants' conceptions of the evidence problem and the relation between these conceptions and the content of their reasoning considered from the point of view of the role of previous experience. The results will be presented first for the medical case and then for the technical case. For each case, first the results from the first analysis concerning conceptions of the evidence problem are presented. Then the results from the second analysis concerning the content of the reasonings are presented and thereafter the relation between the two kinds of results is described. These descriptions of the results of the two cases form the background for a more general discussion of the role of experience in the reasoning about the cases.

THE MEDICAL CASE

Conceptions of the evidence problem

The aspect of the subjects' reasoning about the medical case found to be fundamental and representing the greatest difference between the two groups, concerns what should and/or could be made known through empirical investigations. Since most of the interviewees think that the relation is not known, the main difference in reasoning concerns what kind of evidence is considered possible to obtain and reasonable to search for in order to illuminate the relation. There are three main conceptions of the evidence problem:

Proved. The relation is considered to be already known or to have been proved by means of the investigation. The meaning given to the information is that it is known that chrome in the air is causing lung cancer. The subjects have very little to say about how this may have been proved but see it as a matter of conducting medical examinations of people.

Control. The question of whether or not there is a relation is considered an open one. The main problem is that of dealing with alternative causes or explanations. Rival explanations should be dealt with, it is suggested, by controlling similarities and differences between cases in respects other than that of being exposed to chrome in the air.

Tracing. The question about the relation is seen as complicated. The relation must be studied by tracing the cause through to the effect, or vice versa in the individual cases. The main idea is to bring the cause and effect closer to each other in our knowledge, to reach an idea of the nature of the relation as a basis for establishing a relation and excluding alternative causes and explanations.

The numbers of nurses and technicians expressing these conceptions are shown in table 1.

Table 1. The conceptions of the problem of evidence grouped in the three main categories.

	Nurses	Technicians	Total
Proved	0	3	3
Control	6	9	15
Tracing	8	2	10
Total	14	14	28

The ordering of the categories represents a progression from no aim, because the result has already been achieved, to the aim of finding out what the relation is. The difference between Proved and the two other categories concerns what is supposed to have been made known. The difference between Control and Tracing concerns different kinds of results related to different methodological approaches. The Proved and Control categories seem similar in that the reasoning is focussed upon the question of the existence of a relation. In the Tracing category, on the other hand, the reasoning is focussed on what the nature of the relation may be. If the first two categories are combined, there are twelve technicians to six nurses and in category Tracing there are eight nurses to two technicians. There is thus a quite clear difference between the groups. The overall picture, then, is that in reasoning about a relation between chrome in the air and lung cancer, the technicians favour attempts to show that there is a relation by means of control of similarities and differences and external exclusion of rival explanations. The nurses, on the other hand, favour attempts to trace the cause of illness in different cases in order to arrive at a description of what the relation is.

The content of the reasoning

The suggested relation between chrome in the air and cancer of the lungs has a causal side and an effect side. In considering what the subjects are talking about, there is a clear difference between the nurses and the technicians as to what side of the relation they are talking about. The technicians talk about things that have to do with the cause-side of the relation while the nurses have much more to say about the effect-side, the disease of cancer of the lungs. Eleven of the technicians talk about work processes and work environment. None of the nurses talks about any specific work or environment. One nurse talks about such factors in a hypothetical way and two make general comments on worker protection. All the technicians say something about the medical aspect of the relation. Twelve say that one ought to be able to find chrome in the body or they say something generally about medical data such as X-rays, blood tests and/or post mortem examinations. Seven technicians say something about physical functions. With one exception, these comments are more general than those made by nurses. Two nurses do not say anything about the medical side and three say a little but nonetheless more about medical observations and symptoms than any of the technicians do. The cases of reasoning may be grouped into three categories according to their content.

Dangerous work. The interviewees talk about work processes and industrial work environment that are thought to be related to the incidence of cancer of the lungs. They do not talk at all, or only generally, about medical observations.

Disease. The interviewees talk about medical observations, symptoms and processes in the body indicating and constituting the disease and they talk

about possible causes of the disease. They do not talk about any specific work.

Investigation. The interviewees do not talk about any work, nor, except generally, about medical observations. They focus directly on problems of investigating the relation.

Table 2. The number of nurses and technicians whose reasoning belong to the three categories describing the main differences in the content of the reasonings.

	Nurses	Technicians
Dangerous work	1	11
Disease	11	0
Investigation	2	3
Total	14	14

The reasoning of the nurses and the technicians in the last category are characterized by not being concerned with the content of the relation. Thus, we may conclude that when the nurses and technicians include descriptions of phenomena and situations, these relate to different sides of the relation. In individual cases, there are more fundamental differences, for instance, in that some nurses discuss in great detail physical functions and the character of the disease. However, the characteristics differentiated between in the categorisation represent the most general and clear-cut difference between the two groups.

The technicians' discussion of working processes and environments includes references to their own experiences. Six of them talk about work that is associated with chrome in the air. All of these six also make analogies to work with other similar substances that are known to be, or suspected to be, causes of cancer of the lungs. The five remaining technicians do not talk about chrome but about similar substances. The nurse in the first category wonders about the kind of work involved and makes analogies to work with other substances (but does not refer to personal experience). The nurses who talk more extensively than the technicians about the medical aspect use their knowledge without making reference to specific experiences. Some of them mention that they have been working with cancer patients. They also talk generally about possible causes of cancer of the lungs including a lot of other factors in addition to the kind of substances mentioned by the technicians and also represented by chrome. Such factors are age, heredity, other damage or diseases of the lungs and more general environmental factors such as air pollution.

What most of the technicians and nurses are thus talking about is clearly related to their previous professional experience and knowledge. This is so concerning the specific content and especially so concerning which side of the relation is focussed on and discussed. At the same time we can conclude that the differences in content are related to a difference in what the <u>context</u> is that is implied and referred to when talking about the relation. The technicians think in terms of a context of industrial work and problems caused by dangerous substances. The nurses think in terms of a context of incidences of cancer of the lungs and what might be the cause of the disease in these cases. This difference is not only associated with different contents but also with different <u>perspectives</u> on the whole of the relation. The technicians see

the relation as one between certain substances present in people's work and cancer of the lungs, and the question implied is whether chrome is a dangerous substance. The nurses see the relation as one between cancer of the lungs and possible causes of the disease. The question implied is one concerning what caused the cancer.

The relation between the content of reasoning and the conception of the evidence problem

The conception of the evidence problem is linked to the content and meaning of the relation. This relation is described in the form of combinations of categories in table 3.

Table 3. The relation between the content of the reasoning and the conceptions of the evidence problem.

Content of reasoning	Conceptions of the evidence problem					
	Proved		Control		Tracing	
	N	T	N	T	N	T
Dangerous work	0	3	1	7	0	1
Disease	0	0	3	0	8	0
Investigation	0	0	2	2	0	1
	0	3	6	9	8	2

If we consider the cases of reasoning in the category Dangerous work, in eight of these the evidence problem is seen in terms of control of alternative explanations. The alternative explanations thought of mainly refer to other substances also present in the work situation (and smoking). Three of the

technicians in this first category see the relation as proved by medical evidence although they have very little to say about the medical aspect (category Proved). They seem to think that the relation has been proved as a result of the examination of those who have cancer. The remaining subject combining the categories Dangerous work and Tracing is similar to the three others mentioned in that he refers to medical evidence. He has nothing to say about this but he differs in that he thinks it is difficult to find this evidence. This last case represents an exception to the combination of Dangerous work and Control when the evidence problem is acknowledged (excluding the three in the category Proved). Even of one does not have anything to say about the medical aspect, one may still think that it is the tracing of the medical relation that constitutes the evidence proper. However, the combination of focussing on dangerous substances and suggesting a control approach is very dominant.

If we consider the cases of reasoning placed in the category Disease, they all come from nurses and most of them are combined with a Tracing-conception of the evidence problem. However, three nurses combine such content with a Control-conception of the evidence problem. Again, we wish to point out that one or the other combination is not exclusive although one combination clearly dominates. All but one of the cases of reasoning classified as Investigation combine this character with a Control approach to the evidence problem. They share a focus on the investigation in a more restricted way which does not include a concern for the content in the way the others deal with it. They represent a different context for dealing with the relation which is more methodological in character. This suggests that it is not the association with specific content that is primary, but rather that it is the context of thinking which influences what content is found to be relevant. At the same

time, we may conclude that the same general contexts and meanings of the relation may be combined with different conceptions of the evidence problem, although some combinations are clearly dominant.

The basis for understanding the relation between the categorisations seems to be the context of thinking about the relation. There are three main contexts. One is abstract and methodological in orientation and constitutes a perspective focussing directly on the design of investigations. The two other contexts are oriented towards situations and phenomena of two kinds; dangerous industrial work and the incidence (and treatment) of a disease.

Within the context of thinking directly about investigating the relation, the conception of the evidence problem is primary to the thinking about specific content which also means, to a certain extent, a neglect of content. When the subjects are thinking about dangerous work or the character of the disease, the main direction of dependence is from delimitation of content to the conception of the evidence problem. There are three kinds of indications of this direction of dependence in addition to the very meaning of that dangerous work and disease representing contexts of thinking. First, the categorisation of the content reveals the clearest difference between nurses and technicians and is clearly related to differences in experience between the two groups. Secondly, the thinking about dangerous work and about the disease and causes of the disease comes early in the subjects' reasoning. Thirdly, the treatment of the content reveals familiarity with the kind of content talked about while the treatment of the evidence problem reveals unfamiliarity with this kind of problem.

Conceptions of the evidence problem

The aspects of the subjects' reasoning found to be fundamental and to differentiate between the two groups is similar to those in the medical case. The differences concern what could and/or should be made known through empirical investigations. More specifically, the differences concern the relation between what is considered to be already known about the phenomenon and what is expected to be added through an empirical investigation. This corresponds to the difference between the Proved category and the other categories in the medical case, rather than to the main difference between Control and Tracing which is more methodological in character. The similarities and differences in the main aspect make up four categories.

Already known. New empirical data are considered merely as demonstrating a relation already known.

Proof. New empirical data are considered to show whether there is a relation.

Actual values. New empirical data are considered to provide the actual concrete measures of a generally known relation.

Practical tests. New empirical data are considered to show if and how a theoretically known relation appears in a practical situation.

The numbers of nurses and technicians represented by the categories are shown in table 4.

Table 4. The conceptions of the evidence problem grouped in the four main categories.

Conceptions	Nurses	Technicians
Already known	4	3
Proof	8	0
Actual values	1	5
Practical tests	1	6
Total	14	14

The categories have not only been ordered according to differences between the two groups, but also by taking into account the meaning of the categories. There seems to be a certain logic in the order of the categories. The first category means that one does not deal with the relation between what is known and what is added by means of empirical investigations. In the second category, one deals with the problem only in a general way, not really specifying what is known and what will be added. In the third category, a clear distinction between what is known and added is made, but in a way that does not focus on the evidence problem. In category four, the evidence problem is dealt with in combination with a distinction between what is known and what is added, in the form of a differentiation between theoretical knowledge and practical tests.

There are striking differences between the groups. Eight nurses contribute to the category Proof compared with no technicians, and in the categories Actual values and Practical tests combined, the distribution is eleven technicians to two nurses. The overall picture of the differences between the two groups is the following. The nurses reason about the relation between the size of the

stones and noise from the tyres in a general way. Four of them think that it is already known and eight think that it will be proved by means of an empirical study. The technicians think that the relation is known in principle. Six think that empirical data have the function of giving specific values for practical use. Seven technicians make a distinction between two levels of knowledge: theoretical knowledge and knowledge in practice.

The content of the reasoning

The first question asked after the information had been presented was "Do you know anything about this?". Half of the subjects then answered that they themselves had heard the difference in noise between asphalt surfaces containing smaller and bigger stones. Eleven of these were technicians and three were nurses. The technicians continued in most cases by saying something about the phenomenon in question, i.e. they told the interviewer about some aspect of the relation such as the measurement of noise, the noise from tyres compared with noise from the engine, etc. Seven of the technicians, but none of the nurses, gave an explanation of how noise is caused by the interaction of tyres and surfaces. Thus, the general picture is that eleven of the technicians talked about different aspects of the phenomenon and seven of these gave a description of the causal relation. Among the eleven were the three technicians who did not say that they had heard the difference. Thus, three technicians who had heard the difference did not give any description of the phenomenon.

None of the nurses gave the kind of description the technicians did. Five nurses attempted some analogy with a similar phenomenon as a basis for their expectation of a certain direction of the relation. The rest of the nurses did

not say anything about the content of the relation. The difference between the technicians and the nurses is one in knowledge about the phenomenon. The technicians do not refer to knowledge in the form of subject matter in some discipline. Rather they refer to their own personal knowledge based on their own observations and thinking. The main difference between the two groups as to content of reasoning may be described by two categories.

Personal knowledge. The interviewees refer to and present their own knowledge about the relation, also implying that it is generally known.

No knowledge. The interviewees do not refer to or present any knowledge about the relation. Some assume that the relation is known by others and some that it is not known at all.

Table 5. Numbers of nurses and technicians whose reasoning belong to the two categories describing the main difference in content of the reasoning.

	Nurses	Technicians
Personal knowledge	0	11
No knowledge	14	3
Total	14	14

Although there are three exceptions to a complete group-category correspondence, the difference between the two groups is very clear. The underlying difference in the context of thinking is one between thinking that the relation is something one personally knows about and something that one does not know about. The first context, but not the second, leads to a focus

on the nature of the relation. The difference in context underpins the difference between attempts to describe and explain the phenomenon and not attempting to do so.

The relation between the content of reasoning and the conception of the evidence problem

The conception of the evidence problem is related to the content of the reasoning and this relation is presented in the form of combinations of categories in table 6.

Table 6. The relation between the content of the reasoning and the conceptions of the evidence problem.

Content of reasoning	Conceptions of the evidence problem							
	Already known		Proof		Specific values		Practical tests	
	N	T	N	T	N	T	N	T
Personal knowledge	0	1	0	0	0	4	0	6
No knowledge	4	2	8	0	1	1	1	0
Total	4	3	8	0	1	5	1	6

None of those who refer to their personal knowledge thinks that the evidence problem is one of proving the relation. There is a clear logical relation in this respect between referring to personal knowledge and not thinking that the relation has to be proved. The subjects clearly assume that the relation is already known generally, in principle, and they are not inclined to believe that what they know themselves is something new and unique, assuming rather

that it is indeed also known by others. What is focussed on is the specific characteristics of the relation and of whether the relation exists in its general form in the specific case investigated, i.e. the interviewees do not have a test of the existence of the relation in general in mind.

Among those who do not refer to their own knowledge about the relation and who do not have anything to say about the relation, there are nine (six nurses and three technicians) who think that the relation is already known. Six of these assume that the concern is with a general relation and their reasonings belong to the category Already known, which means that they cannot see any real need for an investigation. Three of them, as with those who refer to their knowledge of the relation, assume that the relation is known in principle and identify an aim which an investigation might have, and the eight remaining nurses who do not refer to any knowledge of their own presuppose that there is no knowledge and that the existence of a relation has to be proved. Thus, there is a very clear pattern of combinations of categories between the two categorisations.

As in the medical case, the relation between reference to and use of previous experience and the conception of the evidence problem seem to be mediated by the context and the content of thinking about the relation. In the medical case, the difference was associated with a focus on different sides of the relation. In the technical case, the difference concerns the relation between what is known and what is expected to be added as a result of new evidence. The technicians' descriptions of different aspects of the phenomenon and their explanations are combined with an assumption that the relation is known in principle. This is also assumed by several of those who do not refer to any

knowledge of the relation. They assume that it is known by others and some of them make analogies with similar phenomena.

The assumption that the relation is not known is apparently necessary for the aim of Proof to seem relevant. Lack of knowledge about the relation seems to be a prerequisite for the assumption. However, there are also nine subjects who do not refer to knowledge about the relation but still assume that the relation is known in principle. In these cases, the assumption seems to be based on a general idea about the kind of phenomenon concerned and the kind of knowledge available within the technical field. This idea represents the subjective context which leads to the assumption that this ought to or must be known in principle within the field. Among those who hold the relation to be known and do not refer to personal knowledge, the nurses and two technicians do not see any need for an investigation as compared to three technicians who do. Among those who refer to personal knowledge about the relation, all but one posit an aim for an investigation. Thus, there seems to be an important difference between thinking that the relation is not known, thinking that it is to be known by others and having an idea about the nature of the relation as being contexts of thinking about the evidence problem.

The dominant combinations of categories are not exclusive but are empirically frequent. Each combination tells us something about the nature of the relation between and the meaning of each category entering the combination. The context of thinking seems to be fundamental and mediates the relation between the content of reasoning and the conception of the evidence problem. As in the medical case, the direction of dependence between the content of the reasoning and the conception of the evidence problem is mainly from the content to the conception of the evidence problem. There are some indications of this in

addition to the meaning of the categories and combinations. The categorisation of the content of the reasoning reveals the most clear-cut difference between the two groups. The question of the nature of the relation seems to come first in the reasoning and the problem of investigating the relation seems to be unfamiliar to the subjects.

DISCUSSION

The role of experience in thinking and acting is very much acknowledged generally but seldom dealt with more specifically. The aim of the present article has been to try to specify the role of experience in some cases of reasoning about two problems of evidence. In the medical case, the role of experience takes the form of nurses and technicians talking about different specific contents, dangerous work on the one hand and the disease on the other. This is related to different implicit formulations of the question to be answered. The technicians imply that it is a question of assessing the risk of being exposed to chrome in the air while the nurses imply that it is a question of finding the cause of the workers' cancer of the lungs. The implied question and the specific content talked about form a unity clearly related to the professional background of the subjects. This unity of question and content thought about might be understood in terms of the placing of the problem in different contexts, which also represent the subjects' contexts of thinking about the phenomenon.

In the technical case the role of experience takes the form of the technicians referring to previous experience and knowledge while the nurses do not make such a reference. Some nurses make analogies with knowledge about similar phenomena. The reference or lack of reference to knowledge about the

phenomenon form a unity with the question implied by the subjects in their reasoning. When combined with reference to knowledge of the phenomenon, the kind of question raised concerns the specifics of the relation. When combined with no knowledge of the relation, the kind of question raised concerns the existence of the relation in general. The unity of question and content may be understood in relation to a context representing the context of thinking of the subject. In the first case, the context is that of thinking that one knows about the relation, and that one reasons on the basis of this knowledge. In the second case the context is that one thinks that one does not know, which either raises the question of the existence of the relation or does not quite give a basis for specifying another aim of an investigation.

Thus, the most general difference in the conception of the evidence problem has been described as one between a concern for demonstrating or establishing the existence of a relation in a general sense and a concern for describing a relation more specifically. The first conception seems to represent the context of a control-variable, conclusion-oriented approach while the latter is more descriptive and content-oriented. In Piaget's work (Inhelder and Piaget, 1958), thinking in terms of control of variables is described as formal reasoning which has the character of using generalized rules in the form of strategies. Recent investigations have shown a variation in the use of such strategies which depends on the content and format of tasks (Kuhn and Brannock, 1977: Pulos and Linn, 1978).

In the present study, we have not described variation in performance in the use of control variable strategies but rather differences in reasoning about evidence where some cases of reasoning include such "strategies". The result represents a basis for emphasizing the importance of the context in which such

strategies are used and also for questioning the focussing on strategies per se. It is the conception of the problem and the aim that makes strategies relevant and they do not seem to be as strategic as may seem to be the case when only the formal aspects of thinking are focussed upon. The results rather give the impression that the subjects approach the evidence problem on the basis of their knowledge of the content and their conception of the aim of the inquiry.

Following Piaget´s (1972) suggestion that the formal reasoning is related to field of expertise, we might expect the nurses to be better at the control variable strategy in the medical case than in the technical case and the technicians to be better at using the control variable strategy in the technical case than in the medical one. We did not present the subjects with a task requiring them to use a control variable strategy, so we can neither support nor argue against his suggestion on the basis of our results. However, the results show that if we consider a broader context of thinking of which the use or non-use of a control variable approach is a part, then the relation to expertise is the reverse. The use of the more formal control variable approach is associated with non-expertise and the use of a less formal descriptive approach is associated with expertise.

If one focusses not on the logical form of the reasoning but on the whole reasoning, the relation between expertise and approach is very understandable. Lack of knowledge is related to a general aim of establishing the existence of a relation that is associated with the more formal control variable approach. Knowledge about the phenomenon is related to a less formal concern for descriptions aiming at improving the understanding of the nature of the relation or its specific characteristics. There is an apparent problem with

the characterization of reasoning as being more or less formal. The problem is related to the focus on structure per se and on the clarity of the structure or the correspondence of the structure to certain criteria. Development of thinking and expertise seems to be well described by the ortogenetic principle presented by Werner (1957) which emphasizes proceeding from "a state of relative globality and lack of differentiation to a state of increasing differentiation, articulation, and hierarchic integration". This description fits very well with the non-expertise, control variable approach preceeding the expertise, descriptive approach.

Earlier research into reasoning has tended to focus very strongly on formal aspects. Contextual factors have mainly been dealt with in terms of variation in formal aspects across different content and formats of reasoning tasks. The present study reveals the importance of considering the subjective context of thinking and the whole of the reasoning activity. The role assigned to the context of thinking is very much in line with the general meaning of experience as described by Husserl (1948) and Dewey (1938). According to this view, the relation between content and forms of reasoning is one within a certain context of thinking. We have found that in some cases the subjects think of the formal aspects of the evidence problem before delimiting the content. This represents a method-based or "strategic" approach to the problem. In most cases where the subjects are in an expert-role, however, they delimit the content before thinking of the formal aspects of the relation. As the subjects have no scientific training, it is quite understandable that they think about content before dealing with the methodological aspects of the problem. However, it is also the case that in research, a line of reasoning from ontological to epistomological and methodological assumptions is often presented as ideal, although not always followed.

In investigations focussing on the formal or structural aspects of thinking, there is an apparent risk that differences between subjects will be generally interpreted as differences in access to forms and structures per se. However, the picture that emerges when the role of experience in a more total sense is considered is that the difference is fundamentally that of a difference in the context of thinking. Furthermore, access to or lack of previous experience and knowledge is fundamental to a reliance on content or form in thinking. Phenomena of thinking apparently have to be regarded as involving previous experience and knowledge and the organizing of content where the principle of organization, the form, is considered as a part of the whole reasoning. This certainly takes a more holistic approach to the investigation of thinking and points to the role of experience as an area of the greatest interest in the study of thinking.

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